# MASCELLI'S CINE WORKBOOK

by

Joseph V. Mascelli, A.S.C.

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## TOOLS

## INTERNATIONAL EDITION

CINE/GRAFIC PUBLICATIONS · HOLLYWOOD

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# HOW TO USE WORKBOOK CALCULATORS

The Cine Workbook's calculators are integrated with each other and with the text, tables, listings and diagrams in the Text and Tool Books. All exposure data is indicated in one-third stop increments. All exposure data that is one full stop apart is printed in red. Lens apertures are in T-Stops — half-stops are displayed in a separate row positioned between full stops.

## CINE FACTORS

The *Cine Factor Exposure System,* especially devised for the Workbook by the author, takes all deviations from normal exposure into account. Normal cine exposure is 1/50th second — based on shooting at standard 24 fr/sec sound speed with a 170-180 degree shutter opening. Factors above 1 are *minus* because they cause an exposure *loss* and require opening the lens diaphragm to compensate. Factors below 1 are *plus* because they cause an exposure *gain* and require closing the lens diaphragm to compensate. Exposure may also be compensated in other ways, such as varying the shutter angle, varying the camera frame rate or push processing the film.

| MINUS CINE FACTORS | PLUS CINE FACTORS |
|---|---|
| (Exposure Increase Required) | (Exposure Decrease Required) |
| Filming above 24 fr/sec | Filming below 24 fr/sec |
| Shutter reduced below 170-180° | Shutter increased above 170-180° |
| Light absorbing filter employed | Film is pushed in processing |

Multiply Cine Factors whenever two or more are involved, regardless of whether they are plus or minus. The answer will provide a single Cine Factor that will handle all of the exposure deviations involved. Multiplying *similar* plus *or* minus Cine Factors will result in a greater single Factor — but multiplying plus *and* minus Factors will partially or completely cancel out the Factor. For example, the camera frame rate may be doubled to 48 fr/sec (Cine Factor 2) and the film pushed 1 stop (Cine Factor .50). The minus factor requiring an exposure increase is *cancelled out* by the plus factor which provides a gain in exposure. (2 × .50 = 1, or normal) Three, four, or any number of Cine Factors may be multiplied in turn to obtain the single overall Factor required for computing the T-Stop. The Workbook lists Cine Factors for all filters, increased or reduced angular shutter openings, camera frame rates, and push processing.

For practical purposes, the Cine Factors on the Cine Calculator have been carried to 64, which will cover most shooting situations. However, for those cinematographers working with higher frame rates, such as used in instrumentation work, or to calculate exposure for heavier filters, or other deviations involving higher exposure increases, the following table is an extension of the Calculator dial. It may be employed by simply counting the number of rows (below) down from 64 and then duplicating the count on the T-Stop dial below 64 to find the effective T-Stop required.

| FACTORS | FR/SEC | FILTER | STOPS INCREASE |
|---|---|---|---|
| 64 | 1,500 | | 6 |
| 80 | 2,000 | | 6 1/3 |
| 100 | 2,400 | ND 2.00 | 6 2/3 |
| 125 | 3,000 | | 7 |
| 160 | 4,000 | | 7 1/3 |
| 200 | 4,800 | | 7 2/3 |
| 250 | 6,000 | | 8 |
| 320 | 8,000 | | 8 1/3 |
| 400 | 9,600 | | 8 2/3 |
| 500 | 12,000 | | 9 |
| 640 | 16,000 | | 9 1/3 |
| 800 | 20,000 | | 9 2/3 |
| 1000 | 24,000 | ND 3.00 | 10 |

## CINE EXPOSURE CALCULATOR

The T-Stop for "Normal" exposure, as ascertained by an incident light and/or reflected light spot meter, or other means, should be positioned opposite the NORMAL row, which indicates 180° shutter angle, 24 fr/sec and Cine Factor 1. The adjusted T-Stop required for any *deviation* from normal, such as increasing or decreasing the camera frame rate, increasing or decreasing the shutter angle, employing a filter, or push processing — may be read opposite that particular row. For example, if T-16 is normal, T-5.6 would be required if the camera is operated at 200 fr/sec. Or, T-11 is required if an ND 0.3 filter is used. Or, T-8 if the shutter angle is cut to 45°. If two or more deviations are involved their Cine Factors should be multiplied. A T-16 normal exposure would require T-5.6 if an ND 0.3 (Cine Factor 2) is used and the shutter is cut to 45° (Cine Factor 4). 2 × 4 = 8, so the T-Stop opposite Cine Factor 8 must be employed.

The calculator's outer row contains the actual exposure gain or loss in T-Stops, for those cameramen who like to think in stops. The T-Stop value of the Cine Factors may also be easily compared across any row.

The T-Stop for an 85 or 85B plus N3, N6 or N9 may be found by setting the T-Stop for exposure with the 85 or 85B opposite the NORMAL row — and reading the adjusted T-Stop opposite the particular ND 0.3, ND 0.6 or ND 0.9 that is required.

The Cine Exposure Calculator permits visualizing the entire gamut of exposure variations at a glance, so that every possible combination may be considered. The advantage of push processing, for example, may be readily seen by simply moving the T-Stop *desired* for filming the scene opposite the 1, 2 or 3 stop PUSH row — to find the *effective* T-Stop actually required for a lower light level. For example, using the film's normal E.I. setting on the meter, position T-2 opposite Cine Factor .50 for a 1 stop push — and find that the scene may be filmed with an exposure light level for T-1.4. Move T-2 to Cine Factor .25 for 2 stops PUSH and a light level of only T-1 is required. Note that T-Stops extend to T-.50 to accommodate *effective* exposure at very low light levels.

The *luminance range* of the scene may be easily computed by simply reading the "hottest" significant highlight (in which detail is desired) with a reflected spot meter — and placing that T-Stop value opposite the NORMAL row. The darkest significant shadow area should then be read and the *Cine Factor* opposite *that* T-Stop indicates the *luminance range* of the scene. For instance, if the highlights read T-16 and the shadows read T-2 the luminance range of the scene is 64:1.

Camera frame rates have been rounded for practical purposes. Frame rates in general use, rather than precise fr/sec rates required, are employed, so that the cameraman may use those found on most cine camera or variable camera or motor speed dials. The problem is compounded because multiples and divisibles of standard frame rates are based not only on 24 fr/sec sound speed, but the old 16 fr/sec silent speed — and the *new* 18 fr/sec 8mm and Super 8 silent speed, which is also used for 16mm sports analysis and other purposes, to conserve film when sound is not required. A bit of cheating is required to make all these fr/sec rates fall into one-third stop increments. Be assured, however, that all frame rates fall within plus or minus 1/12th of a stop accuracy.

## INCIDENT LIGHT CALCULATOR

The Incident Light Calculator is based on normal 1/50th second exposure. The calculator may be used to (1) find the T-Stop required for any available incident light intensity; (2) find the incident light intensity required for any desired T-Stop; (3) find the "fill light" required for any desired lighting ratio. Film Exposure indexes are listed for both ASA and DIN. Incident light levels are displayed in both Footcandles, for English-speaking "feet" cameramen — and Lux, for metric cameramen.

A surface is illuminated by the incident light coming from a source of given power at a given distance. The illumination of one candela at a distance of one foot is known as a footcandle (fc), or one lumen per square foot. The metric unit is one lumen per square meter (or metercandle), termed the "lux." A footcandle should be multiplied by 10.764 to obtain a metercandle or lux value, since 10.764 square feet equal one square meter. However, for practical purposes film manufacturers, and others involved with photometric values, generally multiply by 10, so that it is only necessary to add a zero to a footcandle value to obtain a practical lux equivalent.

When filming in the studio, or on controllable location interiors, it is generally desirable to work to a *predetermined* light level and T-Stop. Simply line up the E.I. of the color film being used alongside the desired light level and read the T-Stop required opposite 1/50th second. Or, line up any desired T-Stop with 1/50th second and find the incident light level for the film's E.I. If filming under uncontrollable available light conditions take a footcandle or lux reading and line up the film's E.I. alongside the light level to find the T-Stop required.

For example, the director of photography may wish to light the studio set for a 200 footcandle (2000 lux) light level, in order to shoot at T-4 with color negative rated at ASA 100 (21 DIN). Or, an existing light location interior may read only 50 footcandles (500 lux) and require a T-2 lens setting for the same color negative. However, the cameraman may shoot at T-4 by rating the film at ASA 400 (27 DIN) and have the lab push it two stops in processing to compensate. Simply turning the dial will display every possible combination of light intensity and T-Stop and indicate the various possibilities available either by switching to another film stock or push processing.

The calculator also indicates the intensity of the fill light required for any lighting ratio from 1½:1 to 16:1. (See: *Lighting Contrast Ratio* portion of EXPOSURE article in TEXT book.) The T-Stop required for the key light is positioned opposite 1/50th second. The T-Stop required for the fill light may be read opposite the desired lighting ratio. For example, if T-4 is used for the key light and a 4:1 ratio is desired, the fill light should read T-8. Or, a footcandle or lux reading may be made by simply moving the key light opposite the desired ratio and reading the fill light intensity opposite the film's E.I. The T-4 reading when moved to 4:1 will indicate 50 footcandles (500 lux) for color negative film with a rating of ASA 100 (21 DIN).

## EFFECTIVE EXPOSURE INDEX CALCULATOR

The Effective Exposure Index Calculator indicates the *effective* ASA or DIN rating of the camera film whenever exposure must be *increased or decreased* because of a deviation from normal filming. Rather than employ the film's actual E.I. and add or subtract the number of stops or fractions of a stop required to adjust exposure — it is simpler to shoot with the film's *effective speed rating.*

The film's normal E.I. is effectively *lowered,* requiring an *increase* in exposure, whenever the camera is operated at *more* than 24 fr/sec; whenever the shutter angle is *reduced* from normal 170-180 degrees; or whenever a light absorbing filter is employed. The film's normal E.I. is effectively raised, requiring *decrease* in exposure, whenever the camera is operated at *less* than 24 fr/sec; whenever the shutter angle is *wider* than normal 170-180 degrees; or whenever the film is pushed in processing.

To find the film's effective Exposure Index, position the film's NORMAL E.I. opposite its actual ASA or DIN rating. Then read the Effective E.I. opposite the Cine Factor being employed — or the stops increase or decrease from normal exposure. For example: a color film with an ASA 100 (21 DIN) would have an effective ASA 16 (13 DIN) when the camera is operated at 144 fr/sec (Cine Factor 6, or an *increase* in exposure of 2 2/3 stops). If the camera were operated at 8 fr/sec, however, the color film would have an effective ASA 320 (26 DIN), because a *decrease* from normal exposure is involved (8 fr/sec has a Cine Factor .32, or a *decrease* of 1 2/3 stops).

Two or more plus or minus Cine Factors may be multiplied to obtain a single combination Factor. The camera may be operated at 96 fr/sec (Cine Factor 4) and the film pushed 1 stop (Cine Factor .50). 4 × .50 = 2, so a Cine Factor 2 would be used to indicate the effective E.I. for both Factors.

The Effective Exposure Index Calculator may be used with the All Purpose Camera Speed Table, the various Filter listings, enlarged or reduced shutter angles, or with any Cine Factor found in the text or on the Cine Exposure Calculator.

It is unwise to change the exposure meter's ASA or DIN rating back and forth from normal to effective E. I. if an occasional shot is involved. This is a dangerous practice because it is too easy to forget to switch — and wind up shooting normal scenes with an effective speed rating, or scenes that require an effective E.I. with a normal rating! Use the effective speed rating *only* when *extensive filming* of a special nature is involved, such as shooting high-speed scenes, or with special filters, or the film is to be push processed. Whenever in doubt, compute the Effective E.I. and also use the Cine Exposure Calculator as a double-check.

The effective film speed may also be found when using an 85 or 85B plus a neutral density filter. Simply line up the 85/85B row opposite the film's normal E.I. and read off the film's effective ASA or DIN speed opposite the particular 85/85B ND combination.

## MULTIPLE CINE FACTOR CALCULATOR

The Multiple Cine Factor Calculator may be used to compute the combination Cine Factor when two or more Factors are multiplied. It is a simple matter to mentally multiply 2 x 4 but odd Factors with decimal places, particularly the plus Factors below 1, cannot always be mentally multiplied with ease and assurance that the answer is correct.

To multiply one Factor by another simply line up the Factors on the left side of the calculator and read the combined Factor on the right. If more than two Factors are involved, multiply the combination by the next Factor, etc.

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Cinematographers, lab personnel, technicians, cinema students and other interested in keeping abreast of the latest motion picture and television standards should write ANSI for a free catalog and ask to be placed on the mailing list to receive information about publication of new standards as they become available. ANSI have a great deal of material available for conversion from the English / American to the metric system. Particularly useful is a large multi-colored wall chart which gives a comprehensive summary of SI units in diagrammatic form. This excellent instruction tool was prepared in an English edition by the Netherlands Standards Institute. For catalog and information write:

AMERICAN NATIONAL STANDARDS INSTITUTE
1430 Broadway
New York, NY 10018

## HOW TO USE COLOR CONTRAST VIEWING FILTER

The ROSCO LABORATORIES *Color Contrast Viewing Filter* aids the cinematographer in *visually* evaluating *lighting* and the *luminance range* of interior and exterior scenes.

The human eye, together with the brain, possesses a unique *luminance adaptability* that sees detail in highlights and shadows *simultaneously* over an exceedingly wide range that may exceed 100,000 to 1 in intensity, under certain conditions. Color film, particularly color reversal film, is incapable of recording detail over such wide luminance ranges. Color negative film can handle a luminance range that does not exceed approximately 200 to 1. Color reversal film, which has less latitude than color negative, will record approximately 100 to 1. Exterior scenes may present a luminance range of 300 to 1 to as high as 1000 to 1. Therefore, the eye sees what color film can record only under exceedingly low luminance ranges.

The contrast of the screened picture will *always* appear greater than the original scene because the naked eye sees a much greater luminance range than color film can record — and color film records a true relationship of tonal values *only on the straight line* portion (middle tones) of the H and D curve, and compresses both shadows and highlights. Eye and color film come closest to matching visual and recorded images when the scene has average (18%) or lower than average reflectance and the lighting ratio is low, on the order of 1½ or 2 to 1.

The *Color Contrast Viewing Filter* may be considered a visual or optical exposure meter because it permits the eye to *evaluate* the luminance range of the scene in terms of how it will be reproduced when projected. The filter is neutral so color values are not affected. The filter transmits approximately 1% of the light so it *visually compresses the luminance range* to approximately that which color film can record. High reflectance areas that appear extremely bright through the filter may burn out — unless exposure is adjusted to favor such areas. Very dark shadowed areas may reproduce black and devoid of detail if normally exposed.

The lowered brightness of the scene as viewed through the filter tends to destroy perception of subject reflectances in favor of illumination changes. Altering the lighting ratio by increasing or decreasing the fill light is thus much easier to judge through the filter than with the naked eye. With experience the key to fill lighting may be adjusted by using the filter, rather than by strict footcandle or lux measurement of the individual light sources. Outdoors, booster lights and reflectors may be positioned and adjusted by using the viewing filter to judge the contrast of the scene with and without their use. Many less experienced cameramen tend to use booster lights or reflectors too close to the subject, producing fill light that overpowers the sun key light. The viewing filter will prove an invaluable accessory for judging intensity of fill light indoors or outdoors.

The viewing filter is also useful for judging *out-of-balance* lighting ratios for special effects. Television commercials and location interiors are often photographed with flaring overexposed highlights, "hot" burned out windows or backgrounds, and other high ratio lighting effects. The lighting balance between foreground subjects and backgrounds is easier to compare visually by use of the filter. The filter is also useful when deep black shadows are desirable, such as in low key scenes or night scenes. The filter will permit judging the quality of the highlights and the cameraman can be certain that the shadows will go black. Exposure for such scenes should favor the highlights to make certain the shadows will be vastly underexposed. Modern fast color film exposed under low light levels often records a surprising amount of shadow detail because of ambient light that "bounces" into the shadows.

The *Color Contrast Viewing Filter* will prove particularly useful to the cinema student or less experienced cameraman who has not yet developed a "cine eye" that *sees* the scene the way the color film will reproduce it when screened. Its conscientious use is an excellent way to gain experience in lighting and judging scene contrast — two of the most important things a cameraman must know in order to record properly exposed color film. The viewing filter is not a miracle cine accessory that will automatically produce better color motion pictures by simply looking through it! Anyone can look — the cameraman must *learn to see.* Motion picture production is the art of visualization. Study the images through the filter. Make a mental, or written, note of the scene, noting particularly the highlight and shadow quality. Later compare the screened images with those observed through the filter. When the scene viewed through the filter appears on the screen as the cameraman *visualized* it — he is on his way to becoming a truly professional cinematographer.

## WORKBOOK VINYL JACKET

When the Workbook's vinyl jacket becomes soiled with use it may be easily cleaned and restored to its original luster by simply wiping with a damp cloth or with a premoistened towelette.

## HOW TO USE GRAY SCALE & COLOR PATCHES

The DELUXE GENERAL INCORPORATED Gray Scale and Color Patches, together with the 18% gray side of the KODAK Neutral Test Card, should be photographed at the beginning of a roll of film, or each time a new set-up is filmed.

The open Workbook should be held in the subject position, preferably alongside a player's face, so that it is in the key light. Angle the book so that the cards are fully lighted. Avoid the *glare angle* — where the cards reflect the light directly into the lens! The Workbook's CINEMA PRODUCTS Slate may be positioned underneath the cards and filmed at the same time to identify the scene. Then zoom tighter so that the two cards fill the frame and shoot an extra foot or two of film. This provides the lab's color timer with a strip of film with specific densities and color patches. The cards are particularly helpful in timing scenes that are off-color, such as scenes filmed with fluorescent illumination. The timer has no idea how the scenes actually looked — but he knows how the cards *should look*! When the 18% gray card is reproduced neutral gray the color is fully corrected. When the gray card, or the middle step of the gray scale, is reproduced so that it prints mid-scale (at whatever printer light number that particular lab uses for mid-scale) the exposure density is correct in the print. The timer's task is made simpler, faster and more accurate because it is easier to correct the gray card and color patches which are *known* quantities — than to correct an *unknown* scene, particularly if it is out-of-color-balance. Most labs, but not all, agree that this technique is an aid to color timing.

With a little experience a cameraman may visually judge how his exposures are hitting by noticing whether the scale is reproduced as it appears — which requires normal exposure, or whether it is underexposed (the blackest black, 2% reflectance, will merge with the black card itself), or overexposed (the lightest, 93% reflectance, will flare or burn out, and the entire scale will appear too light). An excellent way to learn is to shoot normal, under and overexposed shots of the cards and have the lab plot them to show what happens — how the 18% mid-scale step, for example, is moved above and below the middle of the straight-line portion of the H and D curve.

The color patches may be used to test how different color films reproduce the various colors. Under or overexposure will also demonstrate how the colors shift in value. A section of the original film may be spliced on the end of the roll to see how the color patches reproduce on the release prints. Anything involving colored light, color balance, lens color (due to different lens coatings), filters, color effects, etc., may also be tested and compared by shooting the color patches — preferably for comparison with a "neutral" or known *standard* light, color, lens, filter, or other condition. A split-screen shot may be photographed by covering one-half of the frame and exposing the color patches with a known neutral light and color condition, established by previous testing. Rewind the film, either in the camera or darkroom, and protect the exposed side and shoot any desired color effect, new lens, filter, color gel, etc., on the opposite side. A visual evaluation is thus easier to make when the color effect or shift in color balance is projected side-by-side with a normally exposed neutrally color balanced control card. The Workbook slate, with identifying data, should be included in the scene.

The 18% gray side of the KODAK Neutral Test Card should always be filmed together with the color patches. If the card is reproduced in a perfect neutral gray the color balance of the light, film and processing is right on! If the original is off-color and the labs corrects for a neutral balance the *print will then be correct* and the card will appear in a neutral gray. However, most viewers prefer "pleasing" color, rather than "perfect" color, so it is not *always* desirable to correct every scene in the release print to a perfect color balance. Doing so would result in a technically perfect sterile looking film. Most scenes benefit from color effects that enhance their pictorial value. The gray card, however, will also indicate a *shift* in color, so it still aids the timer by being reproduced with a particular yellowish, bluish, greenish (or other color) tint that shows how the scene is shifted from neutral. The cameraman should also learn to "read" the "colored" gray card to interpret how the original shifted in color, or how the print is color corrected.

Shooting, testing, evaluating, and comparing the screen results of the gray card, gray scale and color patches, under various conditions of original photography and release printing, can provide the beginning cameraman with a wealth of experience. Tests made with mixed illumination, fluorescent lights, day-for-night, with colored gels on the lights, or with various color films, lenses, filters, etc., may be much easier to evaluate by including these cards at the beginning or end of a scene. Zoom in so that they fill the frame and present the largest possible images for study.

## HOW TO USE KODAK NEUTRAL TEST CARD

The KODAK NEUTRAL TEST CARD, also referred to as the gray card, is one of the cinematographer's most useful color filming tools. The Test Card has a matte finish to prevent specular or mirrorlike reflections. It is carefully controlled in manufacture so that its gray side reflects 18% and its white side 90% of the incident light. These percentages define the *ratio of incident light to reflected light* evaluated.

The SUBJECT REFLECTANCE RATIO portion of the CINE EXPOSURE text explains how the 18% gray side of the test card is computed. It would be advisable to review that text to better understand evaluation of the gray card.

The Neutral Test Card may be used for determining and/or checking the following:

EXPOSURE
LIGHTING RATIO
LIGHT DISTRIBUTION
BACKGROUND COLOR
LIGHT METERS
COLOR BALANCE

EXPOSURE. To determine exposure for an average scene take a reflected light meter reading of the gray side of the card. On interior scenes the card should be held at the subject position so that it faces halfway between the key light and the camera. A regular reflected light meter with a large acceptance angle should be held about 4 or 5 inches away so that it does not read an area wider than the card. Take care not to shadow the card with the hand or meter. It is simpler and more accurate to read the gray card with a reflected spot meter, such as the PENTAX or MINOLTA, or with the GOSSEN LUNA-PRO with its Variable Angle Spot Meter Attachment. On exterior scenes tip the card back and angle it halfway between the sun and the camera. Outdoors the gray card may be read at the camera position if light conditions are similar to that illuminating the subject. Average overall subject reflectance outdoors on a sunny day is reduced to approximately 12%, due to atmospheric conditions which scatter the sun's specular light rays. A reading from the 18% gray side requires a *one-half stop increase* in exposure to compensate. Both interior and exterior reflected light readings made in this manner will closely approximate those obtained with an incident light meter since both are reading average reflectance and exposing the scene to place this value mid-scale on the straight-line portion of the H and D curve.

EXPOSURE IN VERY DIM LIGHT. The white side of the Test Card reflects *five* times as much light as the gray side so it provides a much higher meter pointer deflection in very dim light. Divide the film's ASA Exposure Index by 5, rounded to the nearest number. Hold the white side of the card in the subject position and take a reflected light reading, preferably with a spot meter. The reading will be similar to that read off the gray side with the normal ASA. For example, a film rated ASA 100 would indicate the same reading off the gray side as ASA 20 off the white side.

Exposure readings from either side of the Test Card should be adjusted if the scene does *not* consist of subject matter of average reflectance. If significant areas in the scene are unusually light give *one-half stop less* exposure with either color reversal or color negative film. If they are unusually dark give *one-half stop more* exposure with color reversal film and *one stop more* exposure with negative color film.

LIGHTING RATIO. The lighting ratio (key-plus-fill compared to fill light alone, where both are superimposed on the subject) should not exceed 3 or 4 to 1 for color scenes in which detail is desired in both highlights and shadows. Color film exposed expressly for television will benefit from an even shorter lighting ratio, on the order of 1½ or 2 to 1. (See: LIGHTING RATIO text in CINE EXPOSURE section.) Either side of the Neutral Test Card may be used. The card should be held at the subject position and faced directly toward the light(s) being read, so that the maximum reading is obtained. Top lights, side lights or other lights that spill on the card should be turned off or "goboed" (shielded). The key-plus-fill lights, whenever they are superimposed on the subject, should be read first. The key light should then be turned off and the fill light read. Whenever the key and fill are not superimposed they may be read individually.

Consult the *Incident Light Calculator* for the fill light exposure required for any desired light ratio. For example, if the normal key-plus-fill exposure is T-4 (for 1/50 second) the fill light only will require T-5.6 if a 2:1 lighting ratio is desired.

LIGHT DISTRIBUTION. The intensity of the incident light throughout the scene may be checked by using either side of the Test Card held so that it faces the camera at various positions throughout the set. This works best with front or slightly angled lights. Extreme side lights, top lights and other lights positioned for modeling or backlighting, should be turned off because they may falsely influence the reading. This is the reason an incident light meter, that integrates all of the lighting, is best for checking light distribution. However, a reflected light meter, particularly a spot meter, may be used if care is exercised in positioning the card in relation to the lights and the camera, and spill light can be avoided. The card may thus be employed, for example, to check on the incident light actually falling on a background wall or drape, rather than just reading the reflected light from the background itself. The incident light reading is important if later during the scene players may walk close to the background and move through a "hot" light used to illuminate a very dark drape.

BACKGROUND COLOR. The reproduction of background colors may be controlled by reading the gray side of the Test Card held in the background position, rather than the background itself. The background will be normally rendered when the illumination falling on the background is approximately the same as that falling on the players. Both subject and background will then be in exposure balance. The background may be *cheated* lighter or darker, if desired, by adjusting the illumination until a proportionally higher or lower reading is obtained from the Test Card. This method is valid only when the players and background are illuminated separately.

METER CHECK. The Neutral Test Card provides an excellent means for checking and comparing reflected light, incident light, and footcandle and lux meter readings. A little experimenting with both the gray side and white side of the card with the various types of meters, under low, medium and high light levels will demonstrate how they compare. For example, the incident light meter reading, at the subject position, should be the same as a spot meter reading off the gray card, and compare with the number of footcandles or lux required for the particular film speed and T-stop being employed. All of these readings may not be right on the button, but they should be approximately the same under similar light conditions — or something is seriously wrong with one or more of the meters. Professional light meters are manufactured and calibrated with remarkable accuracy and will continue to provide accurate readings if they are cared for and stored properly. They should be transported in foam rubber lined weather-proof cases so that they are protected from shock, humidity, salt air and dust. Meters should not be exposed to temperatures above 140° F (60° C). Always check the batteries on meters so powered. Replace batteries often whether they require replacement or not. The price of a battery is small compared to poorly exposed footage. Light meters should be purchased in matched pairs if the budget permits. One should be carefully protected and stored while the other is in use, but they should be used alternately so that each gets a workout at intervals. If matched pairs are too expensive, the next best thing is to purchase one incident light meter and one spot meter — and check the incident light readings against the spot meter reading the gray card. If a third meter can be purchased it should be a footcandle or lux meter. Since most gaffers (chief electricians) possess their own footcandle or lux meter it may not be necessary for the cinematographer to own one. However, the cinematographer's meter and the gaffer's meter should be compared at intervals to be certain they read approximately the same.

COLOR BALANCE. The gray side of the Neutral Test Card may be photographed (together with the gray scale and Color Control patches, if desired) to test the color balance of the light source and/or the color film. When the spectral energy distribution (SED) of the light source matches that of the color film being tested the gray card will appear a neutral gray. The neutral gray image may also be used by the lab when printing the film to correct for a neutral color balance. This may help the lab to correct color film shot under fluorescent lights — by printing the scene so that the neutral card appears neutral gray. This is an excellent method for testing, checking and correcting color balance. However, all color film labs do not agree on this method because the best possible color reproduction of the scene may not always be obtained with a perfectly neutral balance. Certain scenes may look more acceptable with a warmish (yellowish gray) color balance, while others may be more pleasing with a coolish (bluish gray) color balance. All color prints should be judged subjectively. They should reproduce the scenes with *pleasing color* — not necessarily *perfect color.* However, if the cinematographer or producer has a decided preference for warmish or coolish color effects, the particular yellowish gray or bluish gray appearance of the gray card will indicate that the print possesses the preferred color balance. The gray card should be spliced onto the tail end of the original film so that the prints may be judged and compared, particularly if several separate orders are later involved.

## TIME-LAPSE CINEMATOGRAPHY

The TIME-LAPSE table on the following page indicates the time interval required for filming scenes of 10 to 60 seconds duration for actions whose *real time* covers from 8 minutes to 4320 hours (180 days or approximately 6 months).

Example: A 15 second scene is required for action that occurs in 5 hours. Move down the 15 second column to 5:00 and follow that line to the left to find that the interval timer on the camera should be set to take 1 exposure every 50 seconds.

| CAMERA TIMER INTERVAL | | SCREENING TIME (LENGTH OF SCENE IN SECONDS) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 10 | 15 | 20 | 25 | 30 | 45 | 60 |
| | | ACTION TIME (HOURS AND MINUTES) | | | | | | |
| **SECONDS** | **2** | 0:08 | 0:12 | 0:16 | 0:20 | 0:24 | 0:36 | 0:48 |
| | **3** | 0:12 | 0:18 | 0:24 | 0:30 | 0:36 | 0:54 | 1:12 |
| | **4** | 0:16 | 0:24 | 0:32 | 0:40 | 0:48 | 1:12 | 1:36 |
| | **5** | 0:20 | 0:30 | 0:40 | 0:50 | 1:00 | 1:30 | 2:00 |
| | **6** | 0:24 | 0:36 | 0:48 | 1:00 | 1:12 | 1:48 | 2:24 |
| | **7** | 0:28 | 0:42 | 0:56 | 1:10 | 1:24 | 2:06 | 2:48 |
| | **8** | 0:32 | 0:48 | 1:04 | 1:20 | 1:36 | 2:24 | 3:12 |
| | **9** | 0:36 | 0:54 | 1:12 | 1:30 | 1:48 | 2:42 | 3:36 |
| | **10** | 0:40 | 1:00 | 1:20 | 1:40 | 2:00 | 3:00 | 4:00 |
| | **12** | 0:48 | 1:12 | 1:36 | 2:00 | 2:24 | 3:36 | 4:48 |
| | **14** | 0:56 | 1:24 | 1:52 | 2:20 | 2:48 | 4:12 | 5:36 |
| | **16** | 1:04 | 1:36 | 2:08 | 2:40 | 3:12 | 4:48 | 6:24 |
| | **18** | 1:12 | 1:48 | 2:24 | 3:00 | 3:36 | 5:24 | 7:12 |
| | **20** | 1:20 | 2:00 | 2:40 | 3:20 | 4:00 | 6:00 | 8:00 |
| | **25** | 1:40 | 2:30 | 3:20 | 4:10 | 5:00 | 7:30 | 10:00 |
| | **30** | 2:00 | 3:00 | 4:00 | 5:00 | 6:00 | 9:00 | 12:00 |
| | **35** | 2:20 | 3:30 | 4:40 | 5:50 | 7:00 | 10:30 | 14:00 |
| | **40** | 2:40 | 4:00 | 5:20 | 6:40 | 8:00 | 12:00 | 16:00 |
| | **45** | 3:00 | 4:30 | 6:00 | 7:30 | 9:00 | 13:30 | 18:00 |
| | **50** | 3:20 | 5:00 | 6:40 | 8:20 | 10:00 | 15:00 | 20:00 |
| | **55** | 3:40 | 5:30 | 7:20 | 9:10 | 11:00 | 16:30 | 22:00 |
| **MINUTES** | **1** | 4:00 | 6:00 | 8:00 | 10:00 | 12:00 | 18:00 | 24:00 |
| | **1.5** | 6:00 | 9:00 | 12:00 | 15:00 | 18:00 | 27:00 | 36:00 |
| | **2** | 8:00 | 12:00 | 16:00 | 20:00 | 24:00 | 36:00 | 48:00 |
| | **2.5** | 10:00 | 15:00 | 20:00 | 25:00 | 30:00 | 45:00 | 60:00 |
| | **3** | 12:00 | 18:00 | 24:00 | 30:00 | 36:00 | 54:00 | 72:00 |
| | **3.5** | 14:00 | 21:00 | 28:00 | 35:00 | 42:00 | 63:00 | 84:00 |
| | **4** | 16:00 | 24:00 | 32:00 | 40:00 | 48:00 | 72:00 | 96:00 |
| | **5** | 20:00 | 30:00 | 40:00 | 50:00 | 60:00 | 90:00 | 120:00 |
| | **6** | 24:00 | 36:00 | 48:00 | 60:00 | 72:00 | 108:00 | 144:00 |
| | **7** | 28:00 | 42:00 | 56:00 | 70:00 | 84:00 | 126:00 | 168:00 |
| | **8** | 32:00 | 48:00 | 64:00 | 80:00 | 96:00 | 144:00 | 192:00 |
| | **9** | 36:00 | 54:00 | 72:00 | 90:00 | 108:00 | 162:00 | 216:00 |
| | **10** | 40:00 | 60:00 | 80:00 | 100:00 | 120:00 | 180:00 | 240:00 |
| | **12** | 48:00 | 72:00 | 96:00 | 120:00 | 144:00 | 216:00 | 288:00 |
| | **14** | 56:00 | 84:00 | 112:00 | 140:00 | 168:00 | 252:00 | 336:00 |
| | **16** | 64:00 | 96:00 | 128:00 | 160:00 | 192:00 | 288:00 | 384:00 |
| | **18** | 72:00 | 108:00 | 144:00 | 180:00 | 216:00 | 324:00 | 432:00 |
| | **20** | 80:00 | 120:00 | 160:00 | 200:00 | 240:00 | 360:00 | 480:00 |
| | **22** | 88:00 | 132:00 | 176:00 | 220:00 | 264:00 | 396:00 | 528:00 |
| | **25** | 100:00 | 150:00 | 200:00 | 250:00 | 300:00 | 450:00 | 600:00 |
| | **30** | 120:00 | 180:00 | 240:00 | 300:00 | 360:00 | 540:00 | 720:00 |
| | **35** | 140:00 | 210:00 | 280:00 | 350:00 | 420:00 | 630:00 | 840:00 |
| | **40** | 160:00 | 240:00 | 320:00 | 400:00 | 480:00 | 720:00 | 960:00 |
| | **45** | 180:00 | 270:00 | 360:00 | 450:00 | 540:00 | 810:00 | 1080:00 |
| | **50** | 200:00 | 300:00 | 400:00 | 500:00 | 600:00 | 900:00 | 1200:00 |
| | **55** | 220:00 | 330:00 | 440:00 | 550:00 | 660:00 | 990:00 | 1320:00 |
| **HOURS** | **1** | 240:00 | 360:00 | 480:00 | 600:00 | 720:00 | 1080:00 | 1440:00 |
| | **1.5** | 360:00 | 540:00 | 720:00 | 900:00 | 1080:00 | 1620:00 | 2160:00 |
| | **2** | 480:00 | 720:00 | 960:00 | 1200:00 | 1440:00 | 2160:00 | 2880:00 |
| | **2.5** | 600:00 | 900:00 | 1200:00 | 1500:00 | 1800:00 | 2700:00 | 3600:00 |
| | **3** | 720:00 | 1080:00 | 1440:00 | 1800:00 | 2160:00 | 3240:00 | 4320:00 |

# LENS ANGLES

The following tables display *horizontal* lens angles for focal lengths from 3mm to 2000mm for all film formats. Horizontal angles only are shown because a cameraman thinks in terms of *width*, or "how much can I get in the picture"! Art directors, set designers and others interested in vertical angles may compute them by simply dividing the horizontal angle for any focal length and any format, by the aspect ratio of the particular theatrical or television format being used. For example: a 50mm lens used to shoot with a 35mm Academy Aperture has a horizontal angle of 28 degrees. If the film is projected with a 1.85/1 AR the vertical angle would be 15 degrees (28 ÷ 1.85 = 15). The set designer, however, must build the set high enough to "protect" the full aperture because the picture will be shown later on television. He should, therefore, divide the horizontal angle by the 1.37/1 AR of the Academy Aperture, which would result in a vertical angle of 20 degrees.

Lens angles for different film formats may be easily compared. The tables will be useful for choosing lens focal length, or setting zoom lenses at a particular focal length, when the same size image is required for cameras with different film width working side by side. Extremely short focal length lenses, below 10mm, are not generally available for 35mm or 'scope filming, but it is interesting to note what the computer states their angles would be, if available!

The computed tables prove that a commonly believed lens rule is *not* entirely true: that whenever the *lens focal length* is *halved* or *doubled*, the *lens angle* is *doubled* or *halved*. For example, a 25mm focal length lens possesses twice the angle of a 50mm lens, or conversely a lens with double the focal length of another lens possesses half the angular covering power. This rule is approximately true and works for average focal lengths, and even for extremely long telephotos, but it does *not* work with extremely short wide-angle lenses! The rule breaks down particularly with 35mm flat and 35mm 'scope formats where halving the focal length does *not* double the lens angle with wide-angle and extremely wide-angle lenses. This may account for the exaggerated claims made in advertising the covering power of extremely wide-angle lenses!

Set designers and others interested in the actual area covered, in feet and meters, by different focal length lenses at any distance, may employ the SAMUELSON *Field of View Nomograms* in the *TOOL BOOK*. Height and width dimensions may be easily computed for building sets, and lens focal length may be chosen on the basis of stage space available for positioning the camera. Or, conversely, if the height and/or width is known, and the distance of the camera from the set is fixed, such as filming indoors on a sound stage, the lens focal length required may be computed. The advent of the zoom lens has made an infinite number of focal lengths available, so odd focal lengths that fall *inbetween* fixed focal length conventional lenses may be employed to precisely fill the frame with the desired image area.

# LENS ANGLES (HORIZONTAL)

## (Divide Figure by Aspect Ratio to Obtain Vertical Angle)

| LENS FOCAL LENGTH: MM | SUPER 8 | 16mm | SUPER 16 | 35mm FULL | 35mm ACADEMY | 35mm 'SCOPE |
|---|---|---|---|---|---|---|
| 3.0 | 92.1 | 119.1 | 128.4 | 152.9 | 149.6 | 164.5 |
| 3.5 | 83.2 | 111.1 | 121.1 | 148.6 | 144.8 | 162.0 |
| 4.0 | 75.7 | 103.8 | 114.3 | 144.4 | 140.1 | 159.5 |
| 4.5 | 69.3 | 97.2 | 108.1 | 140.2 | 135.6 | 157.0 |
| 5.0 | 63.8 | 91.2 | 102.2 | 136.2 | 131.2 | 154.5 |
| 5.5 | 59.0 | 85.7 | 96.8 | 132.3 | 127.0 | 152.1 |
| 6.0 | 54.8 | 80.8 | 91.9 | 128.5 | 122.9 | 149.6 |
| 6.5 | 51.1 | 76.3 | 87.3 | 124.8 | 119.0 | 147.2 |
| 7.0 | 47.9 | 72.2 | 83.1 | 121.3 | 115.2 | 144.9 |
| 7.5 | 45.0 | 68.5 | 79.2 | 117.9 | 111.5 | 142.5 |
| 8.0 | 42.5 | 65.1 | 75.6 | 114.5 | 108.1 | 140.2 |
| 8.5 | 40.2 | 62.0 | 72.2 | 111.3 | 104.7 | 137.9 |
| 9.0 | 38.1 | 59.1 | 69.1 | 108.3 | 101.5 | 135.7 |
| 9.5 | 36.3 | 56.5 | 66.3 | 105.3 | 98.5 | 133.5 |
| 10.0 | 34.6 | 54.1 | 63.6 | 102.4 | 95.6 | 131.3 |
| 11.0 | 31.6 | 49.8 | 58.8 | 97.1 | 90.1 | 127.1 |
| 12.0 | 29.1 | 46.1 | 54.6 | 92.1 | 85.2 | 123.0 |
| 13.0 | 26.9 | 42.9 | 51.0 | 87.5 | 80.6 | 119.1 |
| 14.0 | 25.0 | 40.1 | 47.8 | 83.3 | 76.4 | 115.3 |
| 15.0 | 23.4 | 37.6 | 44.9 | 79.4 | 72.6 | 111.7 |
| 16.0 | 22.0 | 35.4 | 42.4 | 75.8 | 69.1 | 108.2 |
| 17.0 | 20.7 | 33.4 | 40.1 | 72.4 | 65.9 | 104.9 |
| 18.0 | 19.6 | 31.7 | 38.0 | 69.3 | 63.0 | 101.7 |
| 19.0 | 18.6 | 30.1 | 36.1 | 66.5 | 60.3 | 98.7 |
| 20.0 | 17.7 | 28.6 | 34.4 | 63.8 | 57.7 | 95.7 |
| 25.0 | 14.2 | 23.1 | 27.9 | 52.9 | 47.6 | 83.0 |
| 30.0 | 11.8 | 19.3 | 23.4 | 45.1 | 40.4 | 72.8 |
| 35.0 | 10.2 | 16.6 | 20.1 | 39.2 | 35.0 | 64.6 |
| 40.0 | 8.9 | 14.5 | 17.6 | 34.6 | 30.8 | 57.9 |
| 45.0 | 7.9 | 12.9 | 15.7 | 30.9 | 27.5 | 52.3 |
| 50.0 | 7.1 | 11.7 | 14.1 | 28.0 | 24.9 | 47.7 |
| 55.0 | 6.5 | 10.6 | 12.9 | 25.5 | 22.7 | 43.8 |
| 60.0 | 5.9 | 9.7 | 11.8 | 23.4 | 20.8 | 40.5 |
| 65.0 | 5.5 | 9.0 | 10.9 | 21.7 | 19.3 | 37.6 |
| 70.0 | 5.1 | 8.3 | 10.1 | 20.2 | 17.9 | 35.1 |
| 75.0 | 4.7 | 7.8 | 9.5 | 18.8 | 16.7 | 32.9 |
| 80.0 | 4.5 | 7.3 | 8.9 | 17.7 | 15.7 | 30.9 |
| 85.0 | 4.2 | 6.9 | 8.3 | 16.7 | 14.8 | 29.2 |
| 90.0 | 4.0 | 6.5 | 7.9 | 15.7 | 14.0 | 27.6 |
| 95.0 | 3.8 | 6.2 | 7.5 | 14.9 | 13.2 | 26.2 |
| 100.0 | 3.6 | 5.8 | 7.1 | 14.2 | 12.6 | 24.9 |
| 105.0 | 3.4 | 5.6 | 6.8 | 13.5 | 12.0 | 23.8 |
| 110.0 | 3.2 | 5.3 | 6.5 | 12.9 | 11.4 | 22.7 |
| 115.0 | 3.1 | 5.1 | 6.2 | 12.4 | 11.0 | 21.8 |
| 120.0 | 3.0 | 4.9 | 5.9 | 11.8 | 10.5 | 20.9 |
| 125.0 | 2.9 | 4.7 | 5.7 | 11.4 | 10.1 | 20.1 |
| 130.0 | 2.7 | 4.5 | 5.5 | 10.9 | 9.7 | 19.3 |
| 135.0 | 2.6 | 4.3 | 5.3 | 10.5 | 9.3 | 18.6 |
| 140.0 | 2.5 | 4.2 | 5.1 | 10.2 | 9.0 | 17.9 |
| 145.0 | 2.5 | 4.0 | 4.9 | 9.8 | 8.7 | 17.3 |

# LENS ANGLES (HORIZONTAL)

## (Divide Figure by Aspect Ratio to Obtain Vertical Angle)

| LENS FOCAL LENGTH: MM | SUPER 8 | 16mm | SUPER 16 | 35mm FULL | 35mm ACADEMY | 35mm 'SCOPE |
|---|---|---|---|---|---|---|
| 150.0 | 2.4 | 3.9 | 4.7 | 9.5 | 8.4 | 16.8 |
| 155.0 | 2.3 | 3.8 | 4.6 | 9.2 | 8.1 | 16.2 |
| 160.0 | 2.2 | 3.7 | 4.4 | 8.9 | 7.9 | 15.7 |
| 165.0 | 2.2 | 3.5 | 4.3 | 8.6 | 7.6 | 15.3 |
| 170.0 | 2.1 | 3.4 | 4.2 | 8.4 | 7.4 | 14.8 |
| 175.0 | 2.0 | 3.3 | 4.1 | 8.1 | 7.2 | 14.4 |
| 180.0 | 2.0 | 3.2 | 3.9 | 7.9 | 7.0 | 14.0 |
| 185.0 | 1.9 | 3.2 | 3.8 | 7.7 | 6.8 | 13.6 |
| 190.0 | 1.9 | 3.1 | 3.7 | 7.5 | 6.6 | 13.3 |
| 195.0 | 1.8 | 3.0 | 3.6 | 7.3 | 6.5 | 12.9 |
| 200.0 | 1.8 | 2.9 | 3.6 | 7.1 | 6.3 | 12.6 |
| 205.0 | 1.7 | 2.9 | 3.5 | 6.9 | 6.2 | 12.3 |
| 210.0 | 1.7 | 2.8 | 3.4 | 6.8 | 6.0 | 12.0 |
| 215.0 | 1.7 | 2.7 | 3.3 | 6.6 | 5.9 | 11.7 |
| 220.0 | 1.6 | 2.7 | 3.2 | 6.5 | 5.7 | 11.5 |
| 225.0 | 1.6 | 2.6 | 3.2 | 6.3 | 5.6 | 11.2 |
| 230.0 | 1.5 | 2.5 | 3.1 | 6.2 | 5.5 | 11.0 |
| 235.0 | 1.5 | 2.5 | 3.0 | 6.1 | 5.4 | 10.7 |
| 240.0 | 1.5 | 2.4 | 3.0 | 5.9 | 5.3 | 10.5 |
| 245.0 | 1.5 | 2.4 | 2.9 | 5.8 | 5.2 | 10.3 |
| 250.0 | 1.4 | 2.3 | 2.8 | 5.7 | 5.1 | 10.1 |
| 255.0 | 1.4 | 2.3 | 2.8 | 5.6 | 5.0 | 9.9 |
| 260.0 | 1.4 | 2.2 | 2.7 | 5.5 | 4.9 | 9.7 |
| 265.0 | 1.3 | 2.2 | 2.7 | 5.4 | 4.8 | 9.5 |
| 270.0 | 1.3 | 2.2 | 2.6 | 5.3 | 4.7 | 9.4 |
| 275.0 | 1.3 | 2.1 | 2.6 | 5.2 | 4.6 | 9.2 |
| 280.0 | 1.3 | 2.1 | 2.5 | 5.1 | 4.5 | 9.0 |
| 285.0 | 1.3 | 2.1 | 2.5 | 5.0 | 4.4 | 8.9 |
| 290.0 | 1.2 | 2.0 | 2.4 | 4.9 | 4.4 | 8.7 |
| 295.0 | 1.2 | 2.0 | 2.4 | 4.8 | 4.3 | 8.6 |
| 300.0 | 1.2 | 1.9 | 2.4 | 4.8 | 4.2 | 8.4 |
| 325.0 | 1.1 | 1.8 | 2.2 | 4.4 | 3.9 | 7.8 |
| 350.0 | 1.0 | 1.7 | 2.0 | 4.1 | 3.6 | 7.2 |
| 375.0 | 1.0 | 1.6 | 1.9 | 3.8 | 3.4 | 6.7 |
| 400.0 | .9 | 1.5 | 1.8 | 3.6 | 3.2 | 6.3 |
| 425.0 | .8 | 1.4 | 1.7 | 3.4 | 3.0 | 6.0 |
| 450.0 | .8 | 1.3 | 1.6 | 3.2 | 2.8 | 5.6 |
| 475.0 | .8 | 1.2 | 1.5 | 3.0 | 2.7 | 5.3 |
| 500.0 | .7 | 1.2 | 1.4 | 2.9 | 2.5 | 5.1 |
| 550.0 | .6 | 1.1 | 1.3 | 2.6 | 2.3 | 4.6 |
| 600.0 | .6 | 1.0 | 1.2 | 2.4 | 2.1 | 4.2 |
| 650.0 | .5 | .9 | 1.1 | 2.2 | 1.9 | 3.9 |
| 700.0 | .5 | .8 | 1.0 | 2.0 | 1.8 | 3.6 |
| 750.0 | .5 | .8 | .9 | 1.9 | 1.7 | 3.4 |
| 800.0 | .4 | .7 | .9 | 1.8 | 1.6 | 3.2 |
| 900.0 | .4 | .7 | .8 | 1.6 | 1.4 | 2.8 |
| 1000.0 | .4 | .6 | .7 | 1.4 | 1.3 | 2.5 |
| 1200.0 | .3 | .5 | .6 | 1.2 | 1.1 | 2.1 |
| 1500.0 | .2 | .4 | .5 | 1.0 | .8 | 1.7 |
| 2000.0 | .2 | .3 | .4 | .7 | .6 | 1.3 |

## HOW TO USE ORANGEWOOD STICK

An orangewood manicure stick is the best tool for cleaning the film aperture of film chips or bits of emulsion. Orangewood is fine-grained, takes a good polish, yet is soft enough not to harm highly polished metals, such as film apertures. This does not imply that it should be used to scrape the aperture clean! Any packed on, stuck or hardened film emulsion should be removed with solvent. Any film cleaner, such as freeon or Eastman Kodak Film lubricant, will help loosen hardened emulsion. A bulb syringe or compressed air may be used to clean the gate. Small portable battery powered (camera or car) compressed air units are available for location use. Use caution with compressed air, make certain there is no moisture in the line, and do not blast it onto delicate surfaces. Commercial aerosol cans, which contain no moisture, are safe for use for removing dust, loose emulsion, film chips, hairs, from the film gate. "Dust Off Junior" made by the Falcon Safety Products Company (Mountainside, N.J. 07092) is an excellent pocket size (8 oz.) aerosol cleaner. A soft, worn chamois or a new handkerchief may be used, but use Q-Tips with extreme caution — the cotton tip may hang up if caught on an edge or corner. Do *not* use a brush for cleaning the film aperture! Hairs may get caught in the aperture or the brush may distribute old dirt.

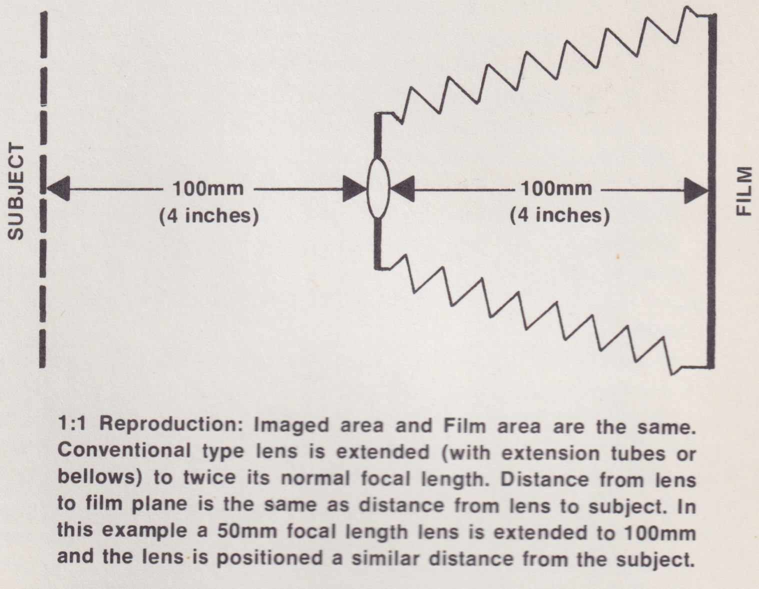
## HOW TO USE SAMUELSON FIELD OF VIEW NOMOGRAMS

Instructions for using the SAMUELSON Field of View Nomograms are listed on the Tool card. Two nomograms are provided — one for feet and one for metric use. The width of the picture may be found for any conventional fixed focal length lens, or any zoom lens at the particular focal lengths indicated, for 16mm, 35mm "flat" and 35mm PANAVISION film formats. Use the HARRISON ruler to line up subject distance from the camera with the focal length of the lens in use. The picture width is indicated where the edge of the ruler intersects the top scale. This may be easily read *through* the clear plastic ruler. The picture height may be found by lining up the ruler with the film format in use and tracing a line on the ruler with the CINEMA PRODUCTS marking pencil. Superimpose the traced line on the edge of the top scale so that the right end of the line is positioned on the picture width — the left end of the line will then indicate the picture height.

These nomograms are part of the SAMCINE KIT, which also includes a *Depth of Field Calculator,* for both conventional fixed focal length lenses and zoom lenses, a *Film Conversion* scale, and other pertinent cine data. Write SAMUELSON FILM SERVICE, LTD. for details, prices and ordering information.

## HOW TO USE EXTREME CLOSE-UP RULERS

The Extreme Close-up Rulers may be employed to find the *magnification* and the *exposure increase* (in stops) required when filming small objects. Magnification is based on the *size of the subject* photographed compared to its *image size on the film.* Note that this has nothing to do with the magnification when the film is projected. When the *subject size* is the *same* as the *image size* the magnification is 1X. This is also referred to as 1-to-1 shooting. The area photographed at 1-to-1 is the same as the film aperture, *regardless of the size of the film.* Therefore, a Super 8, 16mm or 35mm camera will cover an area the same size as the actual film frame when shooting at 1X magnification. When the camera is pulled back, and a wider area is covered, the size of the image on the film becomes relatively smaller in relation to the actual size of the subject. When the film image size is one-half the size of the subject, magnification is .5X.



**1:1 Reproduction: Imaged area and Film area are the same. Conventional type lens is extended (with extension tubes or bellows) to twice its normal focal length. Distance from lens to film plane is the same as distance from lens to subject. In this example a 50mm focal length lens is extended to 100mm and the lens is positioned a similar distance from the subject.**

Magnification has no connection with lens focal length — it is simply the relationship of the subject size to the image size. Therefore, it applies to conventional lenses of *any* focal length, or to zoom lenses *set* at any focal length. When a lens is zoomed, of course, the subject-to-image size relationship is altered so magnification varies during the shot. Depth-of-field is the same at the same f/stops for different focal length lenses *if* the object-to-image size relationship is maintained. A 50mm lens at 500mm distance will produce the same size image as a 100mm lens at 1000mm and record the same near-to-far depth at the same f/stop. The only advantage in using the longer focal length lens is that more working room for lighting will be available between subject and camera. Three-dimensional objects will also display a difference in appearance due to perspective changes produced by near and far viewpoints.

Conventional fixed focal length lenses require an increase in exposure when focused on a very close subject. Conventional lenses are focused by varying their distance from the film — either by rotating the lens or by sliding the lens in a sleeve mount. The f/stop is based on the lens being positioned at infinity. When it is moved away from the film to focus upon closer subjects the lens opening becomes smaller in relationship to the lens focal length. Therefore, it is necessary to employ the *effective* f/stop, rather than the indicated f/stop, to compute exposure. The additional exposure required for a normal focal length lens used to shoot a close-up at several feet is negligible. An increase in exposure is required when a conventional fixed focal length lens is used to photograph a subject closer than *ten times its focal length.* For example, a 50mm (2 inch) lens focused upon an object 500mm (approximately 20 inches) distant, or closer, would require an exposure increase. The increase in exposure becomes greater as the lens is positioned closer to the subject because the lens is extended farther from the film plane.

Zoom lenses are focused by rotating the front lens element, or group of elements, so the rear element of the lens is *not* moved in relation to the film plane. No exposure increase is required, therefore, when using a zoom lens, regardless of the distance of the subject.

Macro lenses and zoom lenses are available that may be focused at extremely close distances. Conventional fixed focal length lenses, however, require extension tubes or extension bellows to permit extreme close-up filming because they cannot be racked out far enough. It is often possible to improvise such tubes by using cardboard mailing tubes and tape, but if extensive work is to be done it is best to employ lens extension tubes or bellows because they provide a sturdy, locked-down set-up. An occasional shot may be improvised. It is possible in an emergency to release the locking fingers on an Arriflex or similar type lens mount, and pull the lens out a short distance and tape it in position. Care must be used, however, to make certain the lens does not fall out of the socket, and masking tape can mess up a lens mount so that it is difficult to clean. A common washer may be used as a "shim" or spacer on a C-mount lens, to extend it and yet hold it screwed in position. A bit of experimenting will provide the washer thickness required. The washer permits the lens to be firmly seated because it is still held tightly in the lens socket by its threads. This improvisation provides a good method for close focusing on an animation or title stand.

The lens rulers make it unnecessary to measure the length of the lens or bellows extension or to use a formula to compute the exposure increase required. Simply choose the Super 8, 16mm or 35mm ruler required. Line up the ruler so that it lies in the same focus plane as the subject. Position the camera and focus the lens so that the left (dotted) line of the ruler is precisely lined up with the left edge of the viewfinder frame. The number that appears at the right side of the viewfinder *underneath* the horizontal line is the *magnification*. The number that appears *above* the horizontal line is the *exposure increase* in stops, or fractions of a stop.

Use the *benday* dotted screen, surrounding the black film format number, at the far left of the ruler, to *focus* upon. The dotted pattern will snap in and out of focus at high magnification and assure sharp focus if positioned in the same plane as the subject.

## REWINDING CAMERA FILM

Many cameramen rewind and break down lab loads of camera film, or short ends, onto daylight loading spools. Rewinding camera film *reverses* the latent image edge numbers and positions them on the *opposite side* of the film. Most labs are not equipped to print edge numbers on the wrong side. If the numbers are printed, they cause editing difficulties because they are not only on the wrong side but they run backwards! Therefore, film should be rewound *twice* to bring the numbers back to their original position. Rewinding camera color film is a very dangerous practice because the emulsion or base side of the film may pick up dust, scratches, abrasions or cinch marks. Rewound film should be used *only* for testing cameras and lenses, or other nonproductive filming — it should not be used to film production footage.

# HOW TO USE LENS FOCUSING CHARTS

The CENTURY PRECISION CINE/OPTICS focusing targets may be used for groundglass focusing by holding the Workbook in the subject position whenever it is difficult to focus or in dim light. Although these targets may be used for checking lens sharpness or for comparing lenses, or a lens with and without a filter, they are not intended for critical lens testing. A series of these targets are generally spread out over a wide area so that both the center and the edges of the image area may be tested. A wall-size lens chart is available from CENTURY at no charge, for those cameramen who wish to comprehensively test their lenses.

The Workbook lens targets will provide a quick reference test whenever the cameraman is in doubt about lens sharpness. The groundglass image may look "soft" or not quite as hair-sharp as it should. Slight unsharpness may be due to improper lens seating or the lens may be jarred out of position due to rough handling or rugged transportation. Zoom lenses, particularly those with relatively short wide-angle focal lengths, and wide-angle lenses, are most troublesome because they require absolutely precise positioning from the film plane. The tolerance involved may be stated as plus or minus zero! A bit of dirt or improper lens seating may cause unsharp images. Zoom and wide-angle lenses should always be checked for cleanliness on all flange and lens socket surfaces and then seated *with a little extra push* that locks the lens all the way home. Cameras with locking lens sockets that *pull* the lens *toward* the film plane perform this important function. Other cameras with locking fingers require a little extra push. The lens should be checked every time the camera is moved and set up if there is a possibility that the lens may have been jarred out of position.

Whenever a lens is sent in for repair or checking it is advisable that the Workbook lens targets be photographed and a short clip of the processed film shipped with the lens. Lens unsharpness is such a subjective evaluation that verbal descriptions are inadequate. It is generally difficult to check the sharpness of a short focal length lens visually on a groundglass. Extreme wide-angle lenses record images with such tiny detail that they are almost impossible to judge with the magnification available on most cine cameras. It is a simple matter, however, to shoot a test target and view the processed film through a microscope or a magnifier.

Lens tests should indicate how many *lines per millimeter* (L/mm) the lens will resolve. A lens always resolves *less* at its maximum aperture. It should be tested at its *optimum sharpness* *aperture,* which is generally about two stops closed from its widest aperture. An f/2 lens, for example, will generally record its sharpest image at approximately f/4. These optimum sharpness figures will vary with different lens manufacturers, so the lens may be tested at different f/stops above and below this figure, if desired, to find its optimum sharpness aperture. Closing the lens smaller than its optimum sharpness aperture increases depth-of-field but does not necessarily increase sharpness! Smaller apertures introduce a phenomenon known as *diffraction* — bending of light rays around a sharp edge, such as diaphragm leaves — so that resolution is adversely affected. Diffraction may seriously deteriorate image sharpness of short focal length lenses. Experienced cinematographers rarely shoot with any lens at apertures smaller than f/11, unless extreme depth-of-field is required and optimum sharpness must be sacrificed.

Image sharpness also depends upon the resolving power of the film. Lens tests should, therefore, be filmed on high resolution emulsions, such as Kodachrome II.

The test targets should be flat lighted. It is wise to bracket exposures to obtain the best possible image density for measurement. Over or underexposure will cause loss of acutance (edge sharpness). Use the 26X target for longer focal length lenses — from 50mm to 120mm. The 26X indicates that the camera should be positioned at 26 times its focal length for filming the test target. The numbers on the chart will then indicate the number of lines per millimeter that the lens resolves. For example, a 50mm lens will be positioned at 26 × 50 mm = 1300mm or 1.3 meters (approximately 4′ 3″). A zoom lens at 120mm focal length would be positioned 26 × 120mm = 3120mm or 3.12 meters (about 10′ 3″). Wide-angle and normal focal length lenses from 6mm to 25mm focal length should be tested with the 144X target. A 12mm lens, for example, would be positioned 144 × 12mm = 1728mm or approximately 1.7 meters (about 5′ 8″).

Analyze the original film, not a print, with a high power magnifier or a 20X microscope. The smallest lines that can be distinguished indicate the lines per millimeter that the lens is capable of resolving. As a rough guide the following focal lengths should resolve the following number of lines per millimeter (L/mm):

| | | | |
|---|---|---|---|
| 10mm | 80 L/mm | 50mm | 65 L/mm |
| 16mm | 75 L/mm | 75mm | 65 L/mm |
| 25mm | 70 L/mm | 100mm | 60 L/mm |

A lens may not test quite as high as these indications yet still record satisfactory images. However, if resolution is substantially less, the optical system should be checked and focus recollimated by a qualified optical technician using appropriate instruments.

## HOW TO USE CAMERA REGISTER TEST GRID

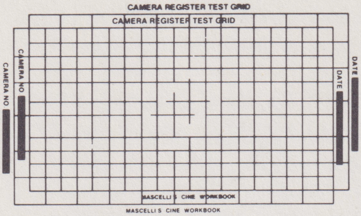
A professional motion picture camera is judged primarily on the registration accuracy of its film movement. The intermittent movement must advance each frame of film, position it accurately in the film aperture, hold it still for exposure, and then repeat the cycle. The complete advance cycle occurs in less than 1/50th second and is repeated 24 times a second at normal sound speed. Professional cameras generally employ some method of pin registration, which accurately positions the film. Certain models use a pull-down claw with a "dwell" at the end of the stroke, that performs the same function. Semi-pro and amateur cameras generally use a pull-down claw, side rails and a spring-loaded pressure plate, with varying results. Even the finest professional cine camera may get out of adjustment due to a bad jam, rough handling or transportation over rugged terrain. Poorly registered pictures will jump, jiggle, weave, vibrate, breathe or otherwise move about on the screen in an objectionable manner.

Precise registration is absolutely essential whenever two or more images are positioned on a single strip of film. This occurs whenever more than one photographic pass is made through the camera; when scenes are double exposed; when split-screen shots are filmed; when scenes are optically superimposed or combined for multiple image effects; when titles are "burned-in" over live action background scenes; and when scenes are front or rear projected and rephotographed with live foreground action. The cameras involved in multiple image work must possess precise registration or one image will move about on the screen in relation to another that is steady.

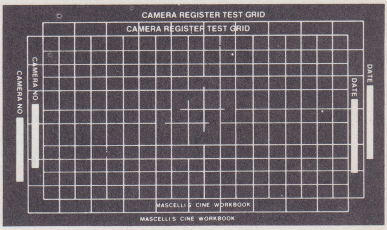
Lack of precise registration may be so slight that it will be undetectable. A slight side-to-side weaving motion may not be noticeable until such scenes are used for title backgrounds, or optically combined with other scenes. They may even be used for front or rear projection if they are scenes of *moving* subject matter, such as traveling background plates. However, a static plate shot with a locked camera will immediately show up the weave when combined with a precisely registered foreground scene.

A camera that lacks precise registration but shoots footage that is acceptably steady when projected should not be discarded. But, it should not be used for filming scenes for optical printing purposes, or scenes for title backgrounds.

The grid may be filmed on the end of any roll of production scenes, whether negative or reversal, color or black and white. A quick test may be shot on black and white negative film which is "slop" developed. Fold the Workbook back so that it forms an easel with the grid facing the camera square-on. Use thumb tacks or masking tape to hold it securely to a table. Or, tape or tack it to a bulletin board or wall. Line up the camera so that the grid fills the frame and lock the tripod securely. If a zoom lens is used, tape the barrel so that the zoom will not drift to another focal length between exposures. Shoot the grid in two passes, with the camera slightly offset for the second exposure. The resulting double-exposure will look like this:


CAMERA REGISTER TEST GRID
CAMERA REGISTER TEST GRID
CAMERA NO
CAMERA NO
DATE
DATE
MASCELLI'S CINE WORKBOOK
MASCELLI'S CINE WORKBOOK

**NEGATIVE**


CAMERA REGISTER TEST GRID
CAMERA REGISTER TEST GRID
CAMERA NO
CAMERA NO
DATE
DATE
MASCELLI'S CINE WORKBOOK
MASCELLI'S CINE WORKBOOK

**REVERSAL**

If registration is perfect the double set of grid lines will appear as a single exposure when projected. If registration is less than perfect the lines will move *in relation to each other*. An unsteady projector will not influence the test since it is the relationship of the grid lines to each other that is meaningful. Use fresh film to shoot the test. Old outdated short-ends may be shrunken. The grid may be double-exposed with any camera except those that use pre-loaded film magazines, such as Super 8, which do not permit winding the film back. Single-8 cameras may be tested because they may be reversed. Cameras that cannot be operated in reverse may be unthreaded and the film wound back in a dark room, then rethreaded for the second pass. A 35mm camera will require outlining the film frame in the aperture with a felt pen, so that it may be rethreaded in frame. This will require removing the lens or turning the turret to an empty lens socket.

Cameras equipped with a matte box, such as the Arriflex and the Mitchell, may use a variation of this test by shooting a split-screen rather than a double-exposed grid. Place a piece of black cardboard *diagonally* across the front of the matte box from one corner to the other. Lock the tripod and shoot the first pass, reverse the cardboard so that it covers the opposite side of the matte box, rewind the film and shoot the second pass. Both horizontal and vertical registration can be checked in this manner.

Both exposures, for either type of test, may be made with the camera going forward. However, if double exposures are required where the camera must film the action in reverse, it would be wise to shoot the test going forward on the first pass and in reverse on the second. If several cameras are used to film a production, all should be tested.

Shoot the test grid at intervals to be certain that precise registration has not been affected by rough handling, transportation, or a film jam. The grid may be photographed on the tail end of a roll of production scenes when a short end is available. This is a good idea on lengthy location trips when film is shipped back to the home office at intervals. Tabs may thus be kept on the condition of various cameras and replacements shipped if required. Be certain to slate the camera number for identification. The grid may be photographed and enlarged for permanent wall mounting. This will be more convenient for camera department personnel who wish to test their cameras periodically.

Another register problem that should be checked is *frame line* registration. Frame lines for various film formats are aligned in relation to the perforations. A misaligned frame line will show on the screen. Such footage cannot be intercut with scenes made with correctly aligned cameras. The correct frame line position may be restored by optically printing the scenes — an expensive procedure available from only a few optical houses equipped to offer this service.

Frame line registration may be checked by laying a short piece of film on top of itself so that heads and tails are reversed. Line up the perforations with the Workbook magnifier and see if the frame lines fall on top of each other. If they do not the camera is shooting out of frame and requires adjustment by a competent cine camera repairman.

The grid may also be used to test zoom lens "drift." It is inherently impossible to design a zoom lens that remains optically centered throughout its zooming range. Slight drifting of the image to one side as the lens is zoomed does not imply that the lens is imperfect or that it requires repair. Image drift is particularly noticeable on a locked perfectly centered static shot that is zoomed into extreme close-up. Most professional cameramen unconsciously correct the drift as they shoot without seemingly being aware of the drifting motion.

To shoot the test set the zoom lens focal length midway in its zooming range and tape the barrel. Line up the camera so that the grid fills the frame. Line up the groundglass cross-hairs, if the glass is so marked, with the cross-hairs on the grid. Lock the tripod securely. Shoot the first pass without zooming. Wind the film back in the camera, or in the darkroom, remove the tape from the lens barrel and shoot the second pass while zooming back and forth. Image drift is sometime greater in one direction than the other. The amount and direction of drift can be judged when projected by noting how the grid cross-hairs separate during the zoom.

## HOW TO USE VIEWFINDER FRAMING TEST GRID

The image area framed by a properly aligned viewfinder should match that recorded on the film. This is particularly important in a mirror-reflex cine camera whose viewfinder is an integral part of the optical system and is employed for both framing and focusing. The test grid may be used to check whether the area framed by the viewfinder matches that photographed. The grid may also be used to check viewfinder groundglass markings for various 35mm wide-screen aspect ratios.

The grid has a 1.33/1 AR (aspect ratio). Super 8, 16mm, and 35mm cameras with an Academy Aperture, will photograph the grid full-frame. Fold the Workbook back in the form of an easel and prop it on a table, or tape or tack it to a bulletin board or wall. Line up the camera so that the grid is squared-off without keystoning and fills the frame precisely, with the outer boundary line just inside the viewfinder. Lock the tripod head securely. If using a zoom lens, tape the barrel so that the focal length does not drift during the test. If the groundglass has centered cross-hairs they should fall precisely upon those of the grid. Shoot a few feet of film, have it processed and check it with the magnifier. The grid should be positioned on the film precisely as lined up in the viewfinder. If it does not, the numbers that are cut off will indicate the direction and amount of error. The grid may be shifted to one side, or up or down, or both vertically and horizontally. Some viewfinders crop the image slightly all around so that the cameraman *sees less* than the area photographed on the film. This allows for printing and projection masking which crops the image area slightly. Projection of the grid may vary with different 16mm projectors, such as Bell & Howell, which crop slightly more image than other projectors.

Viewfinder markings for 1.66/1 AR and 1.85/1 AR may be checked for accuracy. This may be done visually with no need to shoot a test, by filling the frame with the grid and comparing the groundglass markings with those on the grid. Or, if a 35mm Mitchell camera is being tested, a short length of film may be exposed and a frame die-cut with the Mitchell matte cutter and inserted in the viewfinder. The markings on the groundglass should coincide with those on the grid.

Flat wide-screen 1.66/1 and 1.85/1 viewfinder marks provide compositional lines which are *imaginary boundaries,* unless a hard matte is used in the camera aperture, so the screened picture is at the mercy of the projectionist for correct masking and framing! However, the grid may be photographed and projected with the proper mask to observe how the screened image should appear if properly masked and framed.

Panavision and other 2× squeeze 'scope lenses and cameras, and semi-scope (half 35mm frame) cameras, may be checked for viewfinder accuracy by filling the frame with the 2.35/1 area of the grid.

Viewfinder cross-hairs may also be checked for accurate placement by folding a short length of film so that it is laid upon itself head to tails. Line up the perforations with the magnifier and check to see if the cross-hairs coincide. If they appear superimposed or as no more than the thickness of a double line they are sufficiently accurate. However, if they appear as separate lines they are *not* centered on the groundglass.

Viewfinder markings for television fields or 35mm wide-screen formats are often difficult to see against dark backgrounds or when filming with very low light levels. A simple solution to the problem is to *color-code* the groundglass, rather than mark it. Small sections of 85 filter gelatin, or any desired color, may be cut and cemented with a drop of clear nail polish to the top and bottom of the groundglass — so that the outer areas display a colored image and the compositional area remains clear. This may be accomplished by lining up the gelatin while looking through the viewfinder at the grid. Cameras, such as the 16mm Arriflex, permit removing the finder eyepiece which is located directly in front of the groundglass. Others, in which the groundglass slides into position, will require a bit of experimentation to correctly locate the colored gelatin. Color-coding works equally well on interiors or exteriors. When shooting through an 85 for exterior filming, the color-coded area will appear darker. Greater contrast may be obtained for exterior filming by using a complimentary bluish gelatin, if desired.

A very simple method for accurately comparing the viewfinder image with the film image is to *project* a frame of processed test film through the camera lens so that it is superimposed on the grid. The camera and grid must be securely positioned and locked down for this test so that neither is disturbed. Line up the grid so that it fills the viewfinder precisely. Shoot a short length of black and white negative, or hi-contrast title film, and slop-develop it. When it is dry position a frame in the open aperture of the camera and tape it in place. This test works best with a professional camera whose aperture gate may be swung wide open, or whose pressure plate may be removed. A flashlight, or a small light source such as a Tensor lamp, should be positioned at right angles to the gate so that its beam may be reflected, via a bit of tinfoil, through the film. If the grid and camera were not disturbed the images will be superimposed — but the projected image area will differ from the viewfinder image if the optical system comprising the taking lens and viewfinder are not precisely aligned.

Viewfinders should be checked periodically, particularly if the camera is roughly handled on the job, such as in newsreel, documentary or cinema-verité filming, or it has been on a rough location trip where transportation over rugged terrain may have disturbed the optical line-up. The grid may be photographed and enlarged for wall mounting, so that it is easier to film and is always available for use.

## HOW TO USE SLATE

The slate on the back of the vinyl jacket may be used for slating silent scenes or for sound scenes filmed with cameras equipped with built-in marking devices for synchronizing picture and sound. Write on the slate with the CINEMA PRODUCTS self-sharpening thick lead marking pencil. Tip the top of the slate forward for filming so that flaring reflections from the sun or artificial lights will be directed below the lens. Erase with a moistened facial tissue or a pre-moistened "towelette" available at drug stores or supermarkets. CINEMA PRODUCTS will replace marking pencils upon request until supplies are exhausted. Pencils may also be purchased at stationery stores. Ask for Dixon VisAid Overhead Projection Marker No. 30-4. They are available in assorted colors. Dixon also makes a special formula moist towelette called the "VisAid Cleaner" for removal of pencil marks from film or plastic surfaces.

Slates provide information for the film editor in assembling the scenes, and also identification of personnel and equipment. Fill in the Date, Unit number or letter, if several camera crews are involved in filming the production. Film companies generally assign a Production number to each picture for identification through the lab and editing stages. Each roll of film should be slated at the head end with consecutive numbers. This is particularly important on newsreel, documentary and cinema-verité films if individual scenes are not slated. A large Roll number may be written on the inside of the vinyl jacket, if desired, for easier identification of individual rolls of film. A simple method for identifying the *length* of the roll is to use 101, etc. for 100 ft. rolls, and 201, 401, 1001, etc. for various length rolls used by different cameras.

The cameraman's last name should be listed. The camera operator's name may be written under the name of the director of photography if several cameras are used. The camera number, and magazine number — if the camera is equipped with a magazine, should also be listed for identification purposes in case a scratch or other technical problem develops which must be traced to the offending piece of equipment. If the magazines do not have a manufacturer's serial number they may be stenciled with numbers or letters. Magazine covers and lids should also be identified so that they are not mixed up when several magazines are loaded or unloaded at once. Lids for Mitchell-type double compartment magazines should also be lettered "L" and "R" for left and right.

The scene number should correspond to the scene number in the script. A variation on the scene, such as a cut-in close up, a reaction shot, or a different angle, may be listed with the same scene number followed by a letter. For example, the master scene would be slated 312, the medium shot 312-A, the cut-in close-ups

312-B and 312-C. Each new scene or variation on a scene would begin with Take 1, and continue consecutively as many times as the scene is repeated. A new scene would start again with Take 1.

If scene numbers are not used, such as in documentary, newsreel or cinema-verité a simple word or two, such as "General Scenes — Air Show" may be written across the scene and take spaces. The important point is that the scenes be easily identifiable by the editor by referring to the slate and the camera reports, and that equipment trouble can be traced to the camera or magazine causing the problem.

The slate should fill the frame so that it is easily read not only when screened but in the film viewer, or even with the naked eye looking at the film. It is important, therefore, that the cameraman make an effort to shoot a legible slate by zooming in and filling the frame and then zooming back to the wider focal length required to shoot the scene. Or, the slate may be filmed before the scene is shot so that more care can be taken in framing and focusing. This saves film and production time when filming silent scenes, or sound scenes with a camera equipped with an automatic built-in slating device.

Slates are generally shot at the head end of a scene. However, there are times when it is impossible to position a slate because of the camera angle, or the director may not wish to disturb the players, particularly when filming a dramatic scene or working with children. The scene may be filmed and then *tail slated.* A tail or end slate is photographed *upside-down* so that it is not confused with the following head slate identifying the next scene.

## ALL PURPOSE CAMERA SPEED TABLE

This table provides a great deal of useful data for filming below and above normal 24 fr/sec sound speed. It may be used for shooting magnified or miniature scale models, sports, instrumentation studies, comedy sequences, or any scene photographed at other than normal speed. All exposure data is spaced at one-third stop increments, with slight rounding off of camera frame rates to correspond with common usage.

The following formula is used for finding the magnified or miniature scale size:

$$\frac{\text{model size}}{\text{real size}} = \text{scale size}$$

A miniature battleship built to the scale of 3/4 inch to 1 foot would be:

$$3/4 \div 12 = 3/4 \times 1/12 = 3/48 = 1/16 \text{ scale}$$

The formula also works for larger than life-size scale models. An enlarged section of a very tiny moving part may be built to the scale of 16 inches to 1 inch:

$$16 \div 1 = 16\text{X scale}$$

The screen speed of a moving miniature must be *decreased* in proportion to its reduced scale because all linear dimensions appear to be magnified as the square of the magnification of time. The camera must be "overcranked" (operated faster than normal 24 fr/sec) in accordance with its *time-scale,* which is the square root of the reciprocal of its scale. In the case of the 1/16th scale model battleship, the square root of 16 (the reciprocal of 1/16) is 4, so the model would have a time-scale factor of 4. Normal 24 fr/sec × 4 = 96 fr/sec, the proper camera frame rate for converting the model's scale speed to normal screen speed of a real battleship. The time-scale factor is also the exposure factor, or Cine Factor, so the lens aperture should be opened 2 stops from normal 24 fr/sec exposure to compensate.

A moving over-sized scale model will move *slower* than its real counterpart so its screen speed must be *increased.* The 16X moving part will have a reciprocal of 1/16, the square root of which is .25, or 1/4. The time-scale factor of 1/4 X 24 = 6 fr/sec.

Basing the camera frame rate on the miniature's scale size will result in a realistic picture if movement only is required. The tiny battleship will cruise realistically at 96 fr/sec, if built to 1/16th scale — providing the miniature waves behave properly! However, when it fires its guns the exploding shells may require as high as 300 fr/sec, or more, to record the internal explosions, or fire ball within the primary flash, which emphasizes the ship's fire power. Another camera angle filmed at a lower frame rate will be required for the falling debris from the explosion because it will float down unrealistically at high frame rates.

The time-scale factor, based on the miniature scale, should be used as a guide only. Tests should be filmed at various frame rates and with various types of materials, if destruction is required by water, fire or explosives. Scaling down the speed of a moving ship, train or auto is simple, but scaling down miniature waves, water spray, flames, flying debris, etc., requires a great deal of experimentation and ingenuity. Remember that the screened action should approximate what the audience *thinks* it should look like — not necessarily the way it would actually appear in real life. Relatively few people have observed violent destruction on a large scale, so considerable cheating is permissible. Everyone sees moving vehicles every day so a simple shot of a car going over a cliff may be more difficult to film convincingly than a dam bursting!

# ALL PURPOSE CAMERA SPEED TABLE

| SUBJECT SIZE | FRAMES PER SEC. | SCREEN SPEED | EXPOSURE FACTOR | LENS STOPS |
|---|---|---|---|---|
| MAGNIFIED SCALE | BELOW NORMAL CAMERA SPEED | NUMBER OF TIMES SUBJECT'S REAL SPEED | (ALSO PERCENTAGE OF NORMAL CAMERA SPEED) | T-STOPS GAIN (CLOSE DIAPHRAGM) |
| 160X | 2 | 12 | .08 | 3 2/3 |
| 40X | 4 | 6 | .16 | 2 2/3 |
| 16X | 6 | 4 | .25 | 2 |
| 10X | 8 | 3 | .32 | 1 2/3 |
| 4X | 12 | 2 | .50 | 1 |
| 3X | 16 | 1.5 | .64 | 2/3 |
| NORMAL SIZE | NORMAL 24 FR/SEC | REAL SPEED | NORMAL EXPOSURE | -0- |
| MINIATURE SCALE | ABOVE NORMAL CAMERA SPEED | FRACTION (OR PERCENTAGE) OF SUBJECT'S REAL SPEED | (ALSO TIMES NORMAL CAMERA SPEED & TIME SCALE) | T-STOPS LOSS (OPEN DIAPHRAGM) |
| 2/3 | 32 | 2/3 (.80) | 1.25 | 1/3 |
| 1/3 | 40 | 3/5 (.64) | 1.6 | 2/3 |
| 1/4 | 48 | 1/2 (.50) | 2 | 1 |
| 1/6 | 64 | 3/8 (.40) | 2.5 | 1 1/3 |
| 1/10 | 72 | 1/3 (.30) | 3.2 | 1 2/3 |
| 1/16 | 96 | 1/4 (.25) | 4 | 2 |
| 1/25 | 120 | 1/5 (.20) | 5 | 2 1/3 |
| 1/40 | 144 | 1/6 (.16) | 6 | 2 2/3 |
| 1/60 | 200 | 1/8 (.12) | 8 | 3 |
| 1/100 | 240 | 1/10 (.10) | 10 | 3 1/3 |
| 1/160 | 300 | 1/12 (.08) | 12.5 | 3 2/3 |
| 1/250 | 375 | 1/16 (.06) | 16 | 4 |
| 1/400 | 500 | 1/20 (.05) | 20 | 4 1/3 |
| 1/6000 | 1000 | 1/40 (.02) | 40 | 5 1/3 |

# MEASUREMENT

The entire world is slowly moving toward employing one standard system of measurement: the *metric system*. The metric system is variously termed the "International System of Units" or in French "Systeme Internationale d' Unites" — which is abbreviated "Systeme Internationale" or simply "SI". "Metrication" is a word that is now often heard and will become increasingly more vocal in the very near future in countries that are still using English / American feet and inches. The major English-speaking countries — the United Kingdom, United States, Canada, Australia, New Zealand and South Africa — are the only industrial countries still clinging to the cumbersome old system of feet, pounds and Fahrenheit divisions. The United Kingdom began to change to the SI system in 1969. The Congress of the United States voted in 1972 to begin the process of gradual change to the SI system — 180 years after then Secretary of State Thomas Jefferson vainly tried to introduce it to a fledgling republic!

The strange thing is that the English-speaking countries have been using a "half-metric" system for years. How else would a stupid dimension such as 16mm X 400 feet come into use? Also, the inch is divided into "mils" or *thousands*, which is actually a metric type of conversion, so that it may be employed for precisely measuring small items, such as film apertures.

The Workbook is the first attempt to introduce the metric system to English-speaking cameramen and film editors. All of the metric data in the Workbook has been especially computed — it is *not converted* from feet and frames, or from feet and inches, to meters. This is an excellent opportunity for "feet and frame" cameramen and film editors to become acquainted with metric measurement. Film makers who travel about the world will find that both sets of tables or dimensions will prove handy. Conversion tables and conversion factors are also included in the Workbook for temperature, weight and capacity, so that processing formulas, solutions and air temperatures, shipping weight of equipment, may all be converted from one system to the other.

The publishers of the Workbook welcome suggestions for additional tables or other data or information that should be included in future editions. Let's hope that in the not too distant future there will be no need for conversion tables or feet and inches listings — that the English-speaking countries will accept the change to metric without delay because the longer the change-over the greater the magnitude of the task.

# MEASUREMENT CONVERSION

Use multiplying Factor to convert from one system to the other.
EXAMPLE: 5 feet × .305 = 1.525 meters.

## METRIC TO ENGLISH FACTORS

| | |
|---|---|
| Meters to yards (yd) | 1.09 |
| Meters to feet (ft) | 3.28 |
| Millimeters to inches (in) | .0394 |
| Kilometers to miles (mi) | .621 |
| Kilograms to pounds (lb) | 2.21 |
| Grams to ounces (oz) | .0353 |
| Liters to gallons (gal) | .264 |
| Liters to quarts (qt) | 1.06 |
| Milliliters to fluid ounces (fl oz) | .0338 |

## ENGLISH TO METRIC FACTORS

| | |
|---|---|
| Yards to meters (m) | .914 |
| Feet to meters (m) | .305 |
| Inches to millimeters (mm) | 25.4 |
| Miles to kilometers (km) | 1.61 |
| Pounds to kilograms (kg) | .454 |
| Ounces to grams (g) | 28.4 |
| Gallons to liters (l) | 3.79 |
| Quarts to liters (l) | .946 |
| Fluid ounces to milliliters (ml) | 29.6 |

## THE SI (METRIC) SYSTEM

| PREFIX | ABBREV. | MEANS | EXAMPLE: | |
|---|---|---|---|---|
| | | | METERS | EQUALS |
| mega | M | million times | 1,000,000 | megameter |
| kilo | k | thousand times | 1,000 | kilometer |
| | | *the unit alone* | 1. | meter |
| milli | m | thousandth part of | 0.001 | millimeter |
| micro | u | millionth part of | 0.000 001 | micrometer |
| nano | n | billionth part of | 0.000 000 001 | nanometer |

Note: Some metric terms such as *centi* as in centimeter which is a hundredth part of (.01 meters or 10 millimeters) are no longer used. The prefix multipliers and divisions are restricted to successive factors of 1,000.

## TEMPERATURE CONVERSION

(Fahrenheit − 32) × .555 = Celsius
(Celsius × 1.8) + 32 = Fahrenheit
Celsius + 273.2 = Kelvin
Kelvin − 273.2 = Celsius

NOTE: Celsius is the international term now used in place of the more familiar Centigrade. The size of the degrees in the Celsius and Kelvin scale are identical. They just have different starting points: absolute zero for Kelvin, and the ice point for Celsius.

## CELSIUS-FAHRENHEIT THERMOMETERS COMPARISON SCALES

| C° | F° | C° | F° |
|---|---|---|---|
| —17.78 | 0.0 | 25 | 77.0 |
| —15 | 5.0 | 26 | 78.8 |
| —10 | 14.0 | 27 | 80.6 |
| —5 | 23.0 | 28 | 82.4 |
| 0 | 32.0 | 29 | 84.2 |
| 1 | 33.8 | 30 | 86.0 |
| 2 | 35.6 | 31 | 87.8 |
| 3 | 37.4 | 32 | 89.6 |
| 4 | 39.2 | 33 | 91.4 |
| 5 | 41.0 | 34 | 93.2 |
| 6 | 42.8 | 35 | 95.0 |
| 7 | 44.6 | 36 | 96.8 |
| 8 | 46.4 | 37 | 98.6 |
| 9 | 48.2 | 38 | 100.4 |
| 10 | 50.0 | 39 | 102.2 |
| 11 | 51.8 | 40 | 104.0 |
| 12 | 53.6 | 45 | 113.0 |
| 13 | 55.4 | 50 | 122.0 |
| 14 | 57.2 | 55 | 131.0 |
| 15 | 59.0 | 60 | 140.0 |
| 16 | 60.8 | 65 | 149.0 |
| 17 | 62.6 | 70 | 158.0 |
| 18 | 64.4 | 75 | 167.0 |
| 19 | 66.2 | 80 | 176.0 |
| 20 | 68.0 | 85 | 185.0 |
| 21 | 69.8 | 90 | 194.0 |
| 22 | 71.6 | 95 | 203.0 |
| 23 | 73.4 | 100 | 212.0 |
| 24 | 75.2 | | |

## THE ENGLISH/AMERICAN SYSTEM

### LENGTH

| | |
|---|---|
| mile (mi) | 5,280 ft |
| yard (yd) | 3 ft |
| foot (ft) | 12 in |
| inch (in) | 1,000 mils |
| mil | 1/1,000 in |

### WEIGHT (avoirdupois)

| | |
|---|---|
| ton (t) | 2,000 lb |
| pound (lb) | 16 oz |
| ounce (oz) | 1/16 lb |

### CAPACITY (U.S. liquid measure)

| | |
|---|---|
| gallon (gal) | 4 qt |
| quart (qt) | 2 pt |
| pint (pt) | 16 fl oz |
| fluid ounce (fl oz) | 1/16 pt |

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## CINE FILM PERFORATIONS

The shape and dimensions of Super 8 perforations are the *same* for both camera films and projection prints. This is also true of 16mm films. 35mm and 65/70 films employ perforations with *different* shapes and dimensions for negative and positive films. This is necessary because these larger theatrical formats require precise registration for original negatives and intermediate films, and slightly larger positive perforations with a shape that will withstand the wear and tear of being projected hundreds of times.

The *distance between perforations* of camera films and release prints is important. This distance, from the leading edge of one perforation to the leading edge of the next perforation, is referred to as "pitch." Camera stocks are perforated with *short pitch* (a shorter distance between perforations than print stocks), while release print stocks are perforated with long pitch. (This general statement is true for most original photography with system-type camera films used for making release prints. However, certain positive films are also available with short pitch for use in cameras to make titles, mattes, etc., and certain camera films are perforated with long pitch for high-speed instrumentation work.)

A difference in perforation pitch is necessary because release prints are produced on continuous contact printers, in which the film being duplicated and the print stock ride over a sprocketed drum. Since the print stock is on the *outside* of the curve the difference in diameter of a few thousandths of an inch is accommodated by providing the inside film being duplicated with a shorter pitch between perforations.

Non-continuous printers, such as intermittent step printers or optical printers, can handle either long or short pitch film because each frame is independently registered. However, the film employed to produce release prints should always be short pitch.

16mm cine cameras with single claw movements will handle either short or long pitch films. However, professional 16mm cine cameras with registration pins may have difficulty with long pitch films. Trouble arises when long pitch films, such as a high-contrast burn-in title shot on positive film is cut into A and B rolls for release printing. Such scenes may result in unsteady images because both films are long pitch and they will "ride" or "fight" each other when continuously contact printed. Positive stock for camera use should be ordered with short pitch. A long pitch scene, such as an instrumentation scene, may not appear unsteady by itself. However, the combination of two long pitch scenes or a short and a long pitch scene, will show unsteadiness when superimposed because they will move in relation to each other.

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